2.1.5. In Situ Carbon Monoxide Measurements

Quasi-continuous in situ measurements of CO were made at BRW during 1993 using the gas chromatograph-mercuric oxide reduction detector previously described [*Peterson and Rosson*, 1993]. The only difference in the analysis procedure in 1993 compared with previous years was to change the calibration approach from a 2-point linear (two standards) to a 2-point piecewise linear calibration (three standards). The standardization procedure and the reference gases were changed on January 16, 1993. The new reference gases had CO mixing ratios of 77.4, 150.9, and 224.2 ppb CO. As before, all standards were referenced to the CMDL CO standard scale [*Novelli et al.*, 1991]. The instrument was operational 98% of the time.

Preliminary CO hourly-average mixing ratios measured in situ during 1993 are compared with those for 1992 (Figure 2.14*a*,*b*). These data have not been filtered for background conditions (i.e., constrained by wind speed or direction). The time series exhibits periods of low variability punctuated by short-term increases or decreases. These events reflect the influence of local sources and the transport of air parcels from other locations. The seasonal cycle is typical of CO in the high northern latitudes. Both years show maximum CO mixing ratios in late winter and early spring, and a minimum occurs in summer. The annual mean CO mixing ratio determined from the in situ measurements made at BRW during 1993 was 134.6 ppb. In spite of the high frequency variation seen in the in situ record, this annual average agrees well with that determined from weekly flask samples that are collected to represent background conditions (Table 2.5).

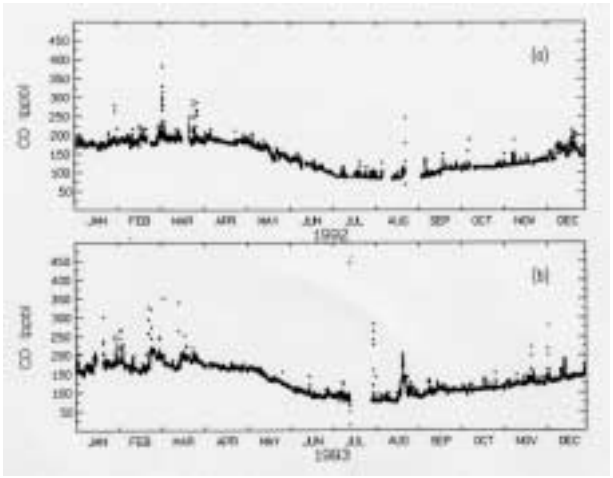

Fig. 2.14. (*a*) Preliminary in situ hourly average CO mixing ratios at BRW in 1992. (*b*) Preliminary in situ hourly average CO mixing ratios at BRW in 1993.

The unfiltered annual mean for in situ measurements made in 1993 was lower than that determined for 1992 (145.4 ppb). This decrease is consistent with the global CO decrease observed in the flask data (see section 2.1.6).

In situ measurements of CO at MLO continued during 1993. The analysis system was similar to that described previously [*Peterson and Rosson*, 1993]. Calibration is conducted using a 2-point piecewise linear calibration scheme. The three standards were changed on December 15, 1993; their CO values were 74.5, 137.4, and 178.6 ppb. The system operated about 94% of the time; some additional data was lost because of problems related to data storage. The annual mean value for 1993 calculated from the in situ data (92.3 ppb) is not significantly different than the value determined from the weekly flask samples (88.5 ± 4.8 ppb).

TABLE 2.5. Flask Network Sites for CO Analysis and Preliminary Annual Mean CO Levels (ppb)

Code	Station	Latitude	First Sample*	Annual Mean†
ALT	Alert, N.W.T., Canada	82°N	April 1992	132.8 (3.5)
ASC	Ascension Island	8°S	Feb. 1989	74.1 (3.9)
BAL	Baltic Sea	55°N	Aug. 1992	184.5 (17)
BME	Bermuda (east coast)	32°N	June 1991	128.4 (6.4)
BMW	Bermuda (west coast)	32°N	July 1991	128.0 (5.0)
BRW	Barrow, Alaska	71°N	July 1988	134.2 (3.2)
CBA	Cold Bay, Alaska	55°N	April 1992	133.8 (4.3)
CGO	Cape Grim, Tasmania	41°S	June 1991	50.7 (0.8)
CHR	Christmas Island	2°N	Dec. 1989	72.9 (2.1)
CMO	Cape Meares, Oregon	45°N	Jan. 1992	137.0 (3.6)
GMI	Guam, Mariana Islands	13°N	Oct. 1989	86.0 (3.0)
GOZ	Dwejra Point, Gozo, Malta	36°N	Oct. 1993	
ICE	Heimaey, Iceland	63°N	Oct. 1992	131.5 (2.6)
ITN	WITN, Grifton, N. Carolina	35°N	July 1992	174.1 (14)
IZO	Izaña Observatory, Tenerife	28°N	Nov. 1991	106.7 (3.7)
KEY	Key Biscayne, Florida	25°N	Aug. 1991	100.3 (4.3)
KUM	Cape Kumukahi, Hawaii	20°N	June 1989	101.8 (4.5)
MBC	Mould Bay, Canada	76°N	Feb. 1992	131.1 (3.4)
MHT	Mace Head, Ireland	54°N	June 1991	126.1 (3.4)
MID	Midway Island	28°N	Jan. 1992	113.4 (5.2)
MLO	Mauna Loa, Hawaii	20°N	July 1989	88.5 (4.8)
NWR	Niwot Ridge, Colorado	40°N	Dec. 1988	117.7 (5.4)
QPC	Qinghai Province, China	36°N	July 1991	116.2 (7.6)
RPB	Ragged Point, Barbados	13°N	March 1993	92.5 (2.8)
SEY	Mahé Island, Seychelles	4°S	Sept. 1990	80.5 (2.5)
SMO	American Samoa	14°S	Sept. 1988	55.3 (1.9)
TAP	Tae-ahn Peninsula, S. Korea	36°N	Nov. 1990	233.7 (28)
UTA	Wendover, Utah	40°N	May 1993	
UUM	Ulaan Uul, Mongolia	44°N	Jan. 1992	151.5 (6.7)

*The month and year air samples were first collected in a glass flask fitted with Teflon O-ring stopcocks and analyzed for CO.

†Preliminary 1993 mean mixing ratios and the standard error are taken from a smooth curve fit to the measured CO in flask samples as described in *Novelli et al.*, 1991.